Updated Requirements Capture

Mini-Solar Power Station

SD1203

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1. Introduction

1.1 Project Description

The Mini-Solar Power Station will consist of two subprojects. The first subproject will be to construct a satellite tracking system known as the solar collector. The solar collector will track the sun ensuring that a maximum amount of sunlight will be collected at all times. The solar collector will contain a satellite dish covered with a reflective Mylar material, but it will also be convertible to allow a solar panel to be easily installed. The solar panel will be installed on the front face of the satellite dish over the Mylar material. When the satellite dish does not have the solar panel installed, the reflective Mylar material will reflect the sunlight to the dish's focal point. A hollow copper coil tube, which contains continuously running fluid, will be placed at the focal point. As the sunrays are reflected and focused at the copper coil tube, essentially at one point, the copper coil will begin to heat up which will consequently heat the fluid inside the coil. Thermal insulated tubing will connect the copper coil to a water reservoir. A water pump will be used to circulate water between the coil and the water reservoir so the temperature rise from the water can be measured. The amount of heat collected from the sun can in turn be calculated. Using data acquisition, the temperature from the water reservoir and the temperature at the focal point will be collected and plotted in real time using LabVIEW. When the solar panel is installed, the energy obtained will charge one 12-volt rechargeable battery. The battery will run a 300-watt inverter so common household appliances can be used.

The second subproject includes constructing a mechanical fixture containing a heat/light source to simulate the rising, setting, and latitudinal movements of the sun. The fixture will be used in correspondence with the above-mentioned satellite dish and serve as a testing device to prepare the Satellite Tracker for operation outside. A 250W infrared heat lamp will be the source of heat and will be used to represent the sun. A dimmer switch will be used with the heat lamp, which will dim the heat lamp to represent cloud cover. As stated above, temperature data will be collected and plotted in LabVIEW. With the dimming of the lamp, the decrease in temperature should be evident in the LabVIEW plotted data. Figure 1.1 is the block diagram of the overall project.

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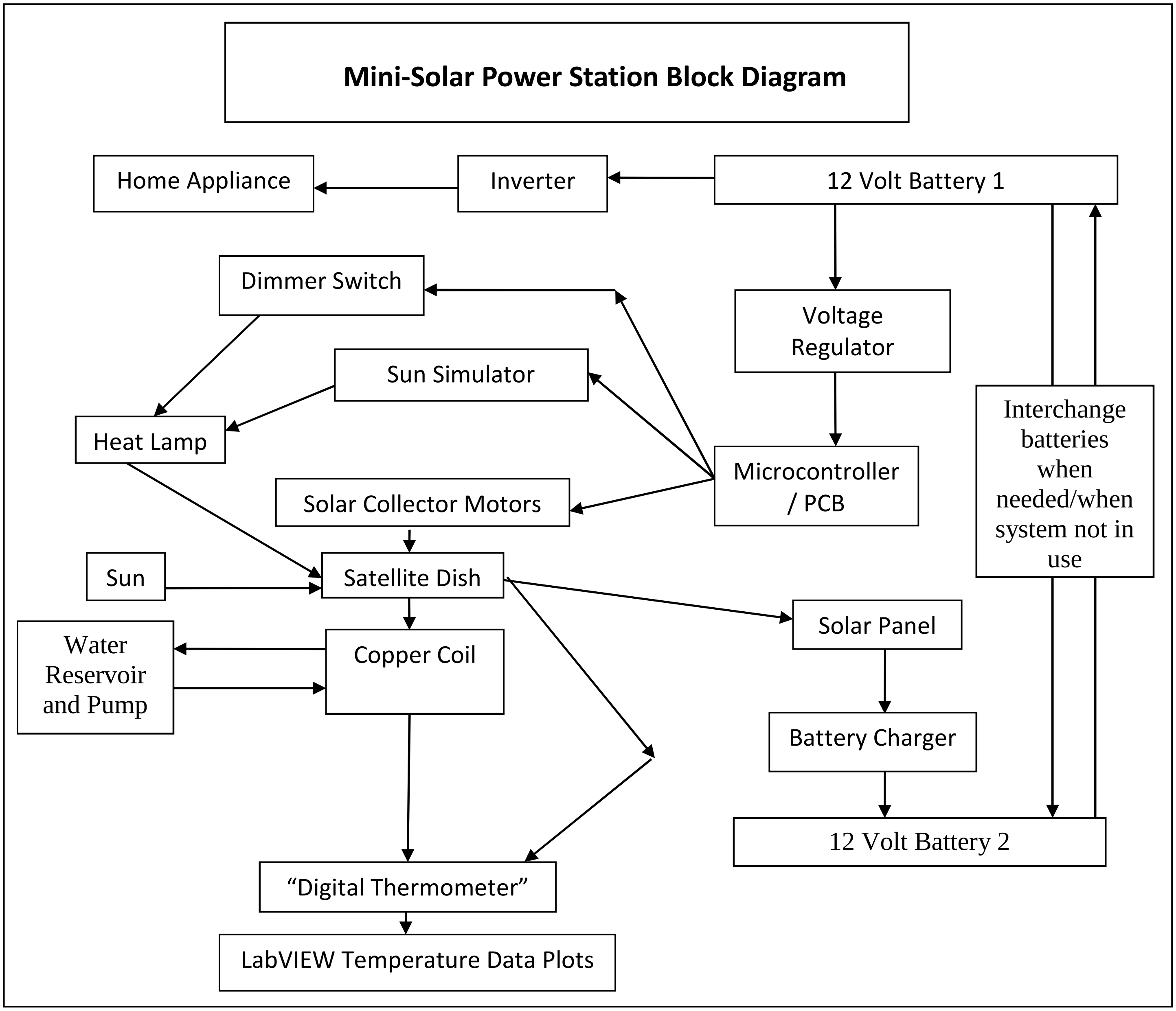

Figure 1: Mini-Solar Power Station Block Diagram

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2. Project Requirements

2.1 Electric Drives

2.1.1 Solar Collector

2.1.1.1 Two motors will be used to track the movement of the sun. One stepper motor will control motion of the dish in the x direction (horizontally) and a linear actuator will control motion in the y direction (vertically).

2.1.2 Sun Simulator

2.1.2.1 Two motors will be used to simulate the movement of the sun. One stepper motor will move the heat bulb along the simulator track, simulating the rising and setting of the sun. A linear actuator will provide ±15 degrees of tilting in two directions for the track, simulating the latitudinal movement of the sun.

2.2 Heat and Electricity Conversion

2.2.1 Solar Collector

2.2.1.1 A water pump will pump water from a water reservoir through insulated tubing to the copper coil. Insulated tubing will connect the copper coil to the water reservoir on the return path, forming a closed loop system producing a continuously running water system.

2.2.1.2 A thermistor (heat sensitive resistor) will be immersed in the water reservoir to measure the water temperature reading. Water temperature data can then be graphed and collected using LabVIEW.

2.2.1.3 A solar panel will be used as the energy-collecting device. Guide rods will be used for proper placement of solar panel onto the satellite dish. Energy obtained will charge one 12V rechargeable battery. A second (charged) battery will be used to run the overall system. The batteries will be interchanged when needed, preferably when the system is not in use.

2.2.1.4 A 300-350W inverter will convert the 12V DC (from the rechargeable batteries) to AC to power common household appliances.

2.3 PIC18 Microcontroller (MCU)

2.3.1 Solar Collector

2.3.1.1 The MCU will control both motors. The dish will be made to track the movement of the sun (and heat lamp) using photocells (light sensitive resistors) combined with a comparator circuit. The photocells are used to detect the sunlight. A comparator is used to decide which photocell is receiving the highest amount of light.

2.3.2 Sun Simulator

2.3.2.1 The MCU will control both motors. Using a series of pulleys, the stepper motor will be used to "push" and "pull" the sheave pulley, connected to the heat lamp, to mimic longitude sun movement. The linear actuator will be used to add ±15 degrees (from the zero starting point), thus mimicking latitude movement.

2.3.2.2 The MCU and pulse width modulation (PWM) will control the dimmer switch. The dimmer switch will be used with the heat lamp, which will dim and brighten the heat lamp to represent cloud cover. With the dimming of the lamp, the decrease in temperature should be evident in the LabVIEW plotted data.

2.4 Data acquisition and Monitoring

2.4.1 **Solar Collector**

2.4.1.1 Using an NI DAQ and LabVIEW graphical programming software, real time temperature of the heated water will be displayed on a graph and the current temperature will be displayed on a numerical display. Temperature data will be logged for future analysis and comparison.

2.4.1.2 The launching of the tracking function will be controlled via a light intensity monitor. The light intensity monitor will turn the tracking function on when the sunlight intensity is above a preset level, and turn the function off when the sunlight intensity drops below the preset level. This will ensure that the system will shut off during night or circumstances like cloudy or rainy days that does not provide enough solar power to generate the power to supply the system itself. The light intensity monitor will (possibly) be implemented using a photo resistor, a comparator, and the MCU accompanied with proper code.

2.5 Mechanical Fixture

2.5.1 **Solar Collector**

2.5.1.1 The project will use a standard slim line satellite dish (one used for Direct TV satellite) and the mechanical fixture will be composed of metal and wood. Mylar will be adhered to the inside of the satellite dish to create a reflective surface.

2.5.1.2 ¼"- ¾" hollow copper tubing will be coiled at the satellite dish's focal point. ¼"- ¾" plastic insulated tubing will be used to connect the copper coil to the water reservoir.

2.5.1.3 All PCB's will be enclosed. Goal is to stay under the updated budget.

2.5.2 **Sun Simulator**

2.5.2.1 Arch material will be made of 10' long ¾" EMT (or equivalent). An additional 10' long arch ¼" or ½" EMT (or equivalent and smaller) will be placed above the first arch to help secure the pulley moving along the arch, preventing front and back swaying. The base structure will be made of wood.

2.5.2.2 All PCB's will be enclosed. Goal is to stay under the updated budget.

3. **Project Summary**

The goal of this project is to create a functional satellite tracking system that is operational outside using natural sunlight. With the Mylar reflective material, the reflected sun energy will heat liquid running through a copper coil connected to a water reservoir. Temperature data will be plotted real time using LabVIEW, so decrease in temperature due to cloud cover should be easily recognizable. When the solar panel is installed, we intend to convert this energy into electricity to charge one 12-volt battery. A second charged 12-volt battery will then run a 300-watt inverter, which will allow for use of household appliances. This approach will be fun and challenging, and it will require each group member to work independently and collaboratively, utilize previously learned information, and expand our technical competencies through research and development. The overall goal of the project is to have a fully functional mini-solar power station functioning outside using natural sunlight.

"This document describes all project requirements set forth by the advisor and/or client. Grading will be performed at the end of the semester according to the level at which these requirements are met."

Approval and Sign off:

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Jeff Erickson: ____ Date: ____________

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